Developing Seasonal Predictive Capability for Drought Mitigation Decision Support

PI: Ximing Cai[1]; Co-PIs: Jae Ryu[2], Xin-Zhong Liang[3], Praveen Kumar[1], Mark Svoboda[4], Cody Knutson[4], Donald A. Wilhite[4]

1: Department of Civil and Environmental Engineering, University of Illinois, Urbana
2: Department of Civil and Environmental Engineering, University of Idaho
3: Department of Atmospheric and ocean Sciences, University of Maryland
4 National Drought Mitigation Center (NDMC), University of Nebraska-Lincoln

Project Information

Project Summary: The project develops short-term (2-week) and seasonal predictive capacity for real-time decision support to improve irrigation scheduling and reservoir operation and for seasonal agricultural planning.

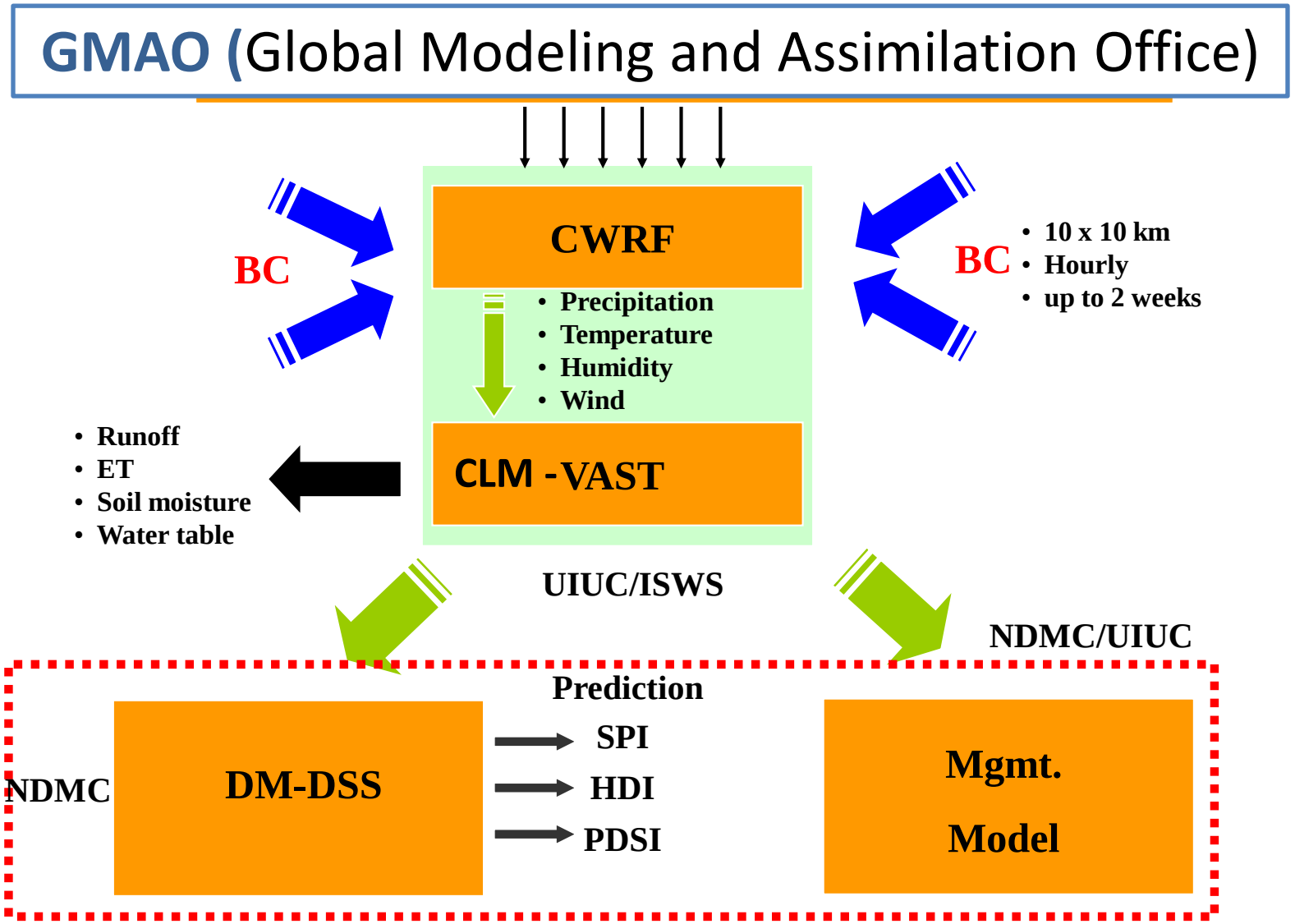
Partner(s) / User Communities: Two national users' associations (Irrigation Association- IA, and Corn Growers Association – CGA) and two local agencies (Central Illinois Irrigated Growers Association coordinated by Mason County Farm Bureau, Nebraska Department of Natural Resources).

Key datasets and Scientific and Technical Tools

Earth Science Products:
NOAA NCEP Reanalysis 2 (RII) and NASA Global Modeling and Assimilation Office (GMAO) coupled General Circulation Model (GCM) and MODIS.

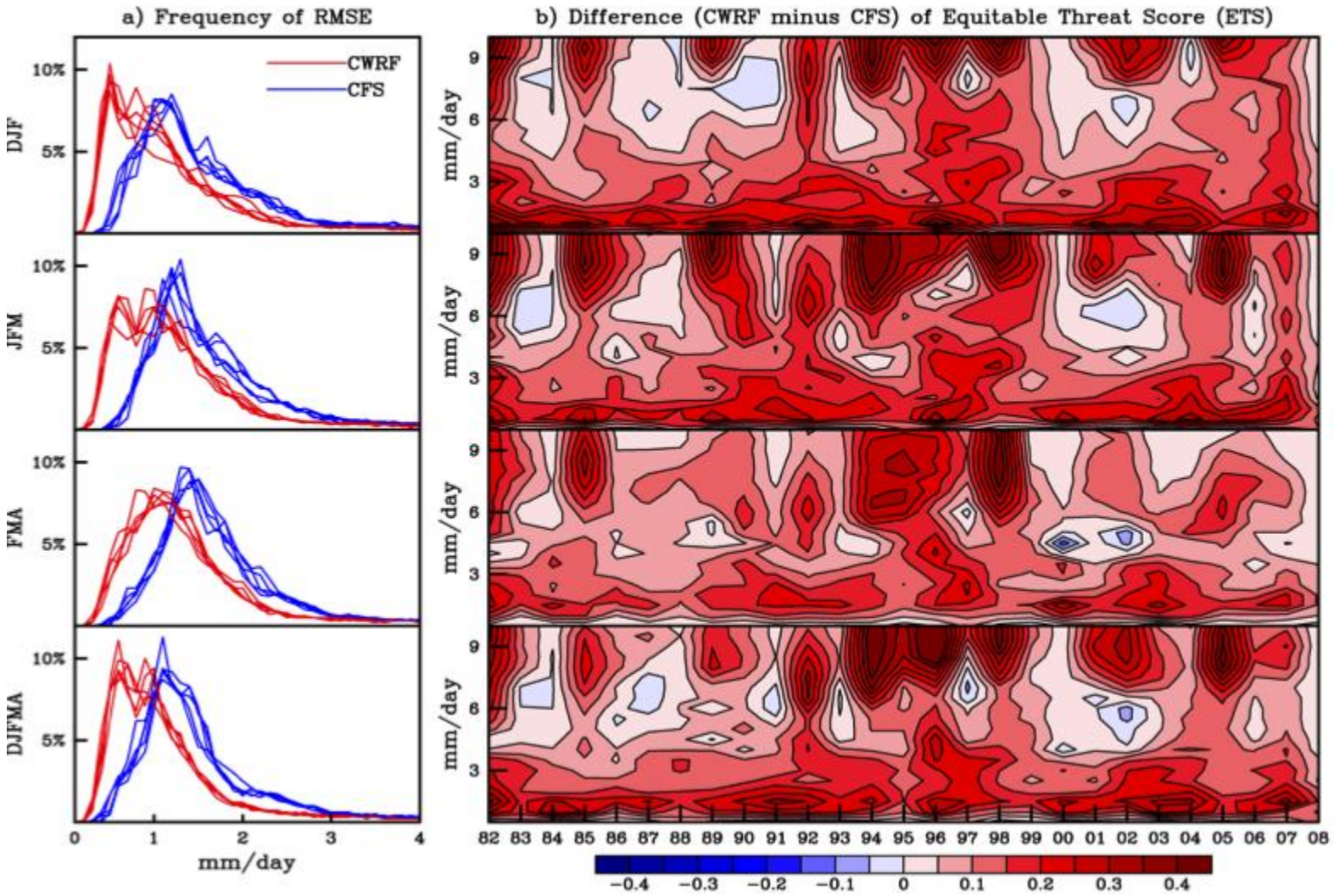
Scientific and technical tools:
CWRF: Climate Extension of Weather Research and Forecast Model
US Drought Monitor (National Drought Mitigation Center)
Decision Support Models Real-time decision models using the CWRF short-term forecasts for irrigation scheduling and reservoir operation, respectively; an agricultural planning model using seasonal forecasts

Approach Overview



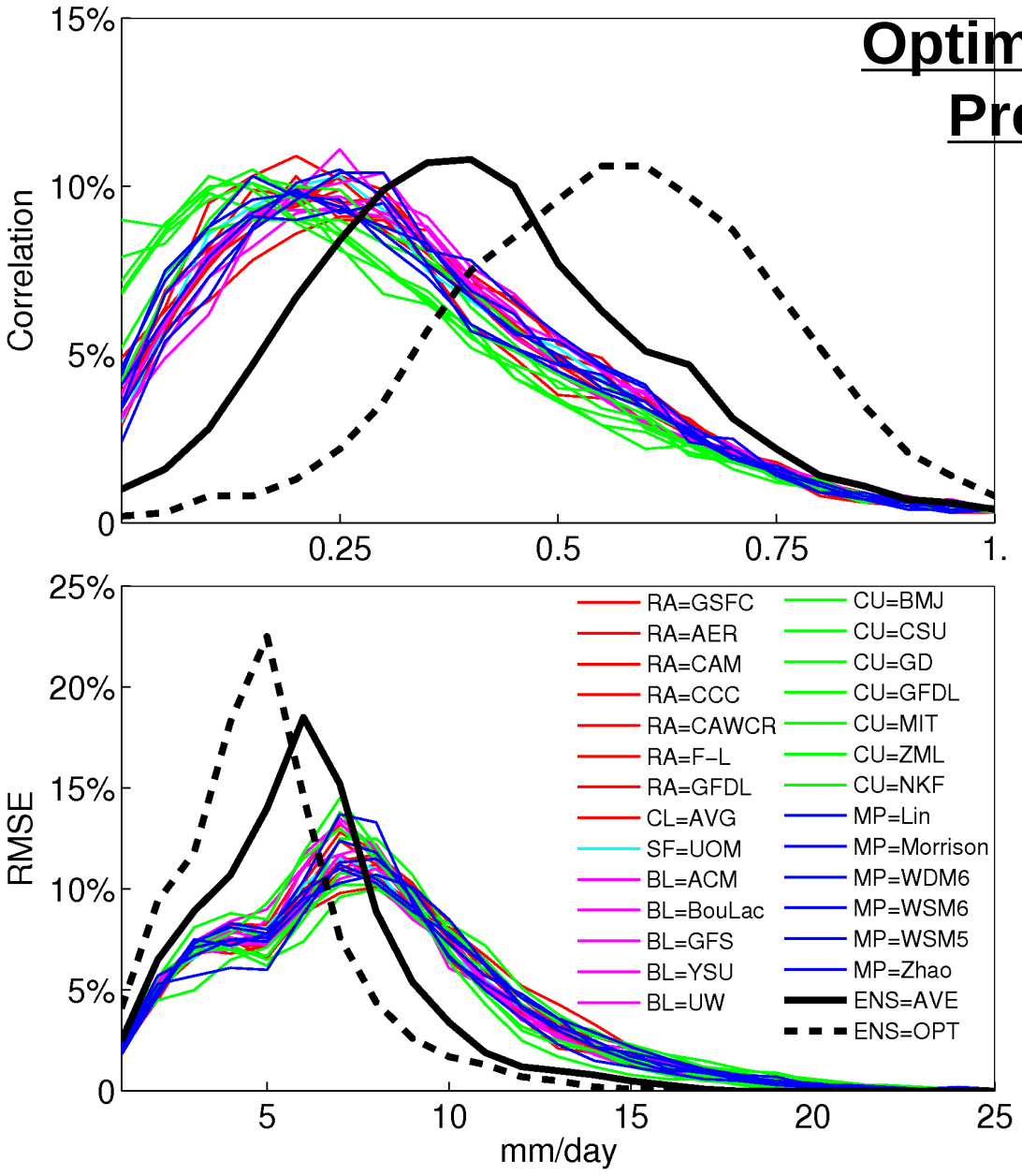
CWRF: Climate extension of Weather Research and Forecast model
CLM-VAST: Common Land Model enhanced by 3D Volume Averaged Subsurface Transport

CWRF Can Improve Seasonal Climate Prediction



a) Spatial frequency distributions of root mean square errors (*RMSE*, mm/day) predicted by the CFS and downscaled by the CWRF and **b)** CWRF minus CFS differences in the equitable threat score (*ETS*) for seasonal mean precipitation interannual variations. The statistics are based on all land grids over the entire inner domain for DJF, JFM, FMA, and DJFMA from the 5 realizations during 1982-2008. *From* Yuan and Liang 2011 (GRL).

Optimized Physics Ensemble Prediction of Precipitation In summer 1993

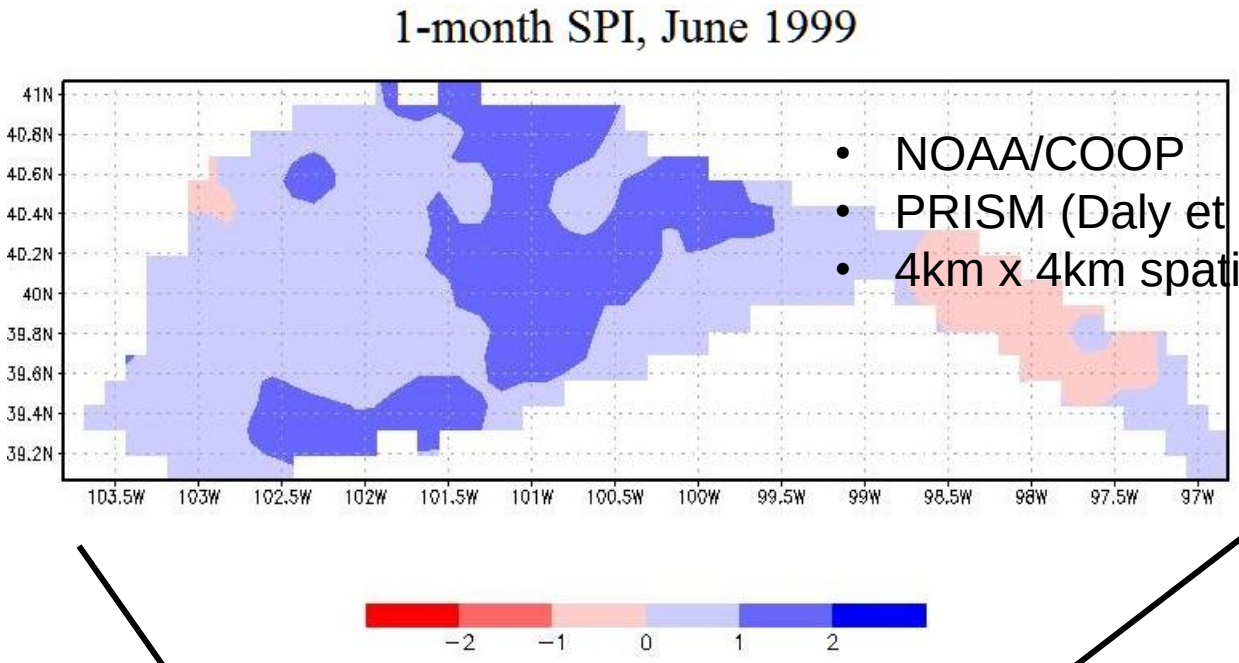


The physics ensemble mean substantially increases the skill score over individual configurations, and there exists a large room to further enhance that skill through optimization of the ensemble.

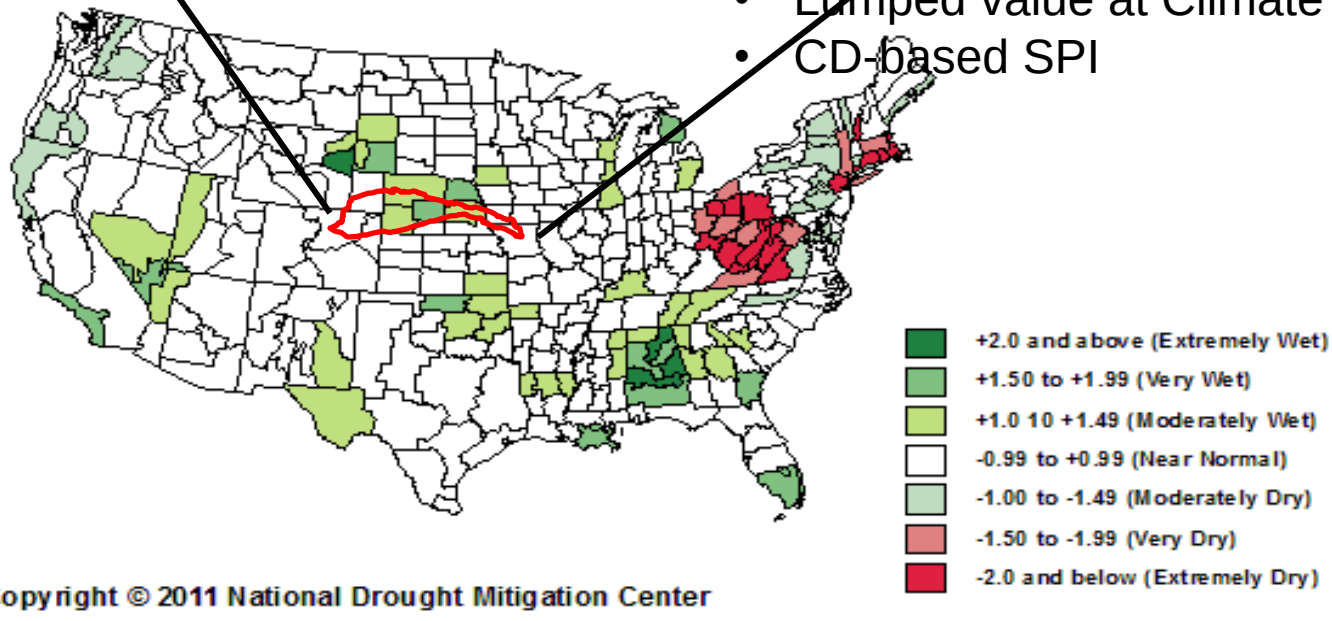
Spatial frequency distributions of correlations (*top*) and rms errors (*bottom*) between CWRF and observed **daily mean rainfall variation**s in summer 1993. Each line depicts a specific configuration in group of the five key physical processes (*color*). **The ensemble result (ENS)** is the average of all runs with equal (Ave) or optimal (OPT) weights, shown as *black solid* or *dashed* line.

Liang, X.-Z., et al., 2012: Regional Climate-Weather Research and Forecasting Model (CWRF). *Bull. Amer. Meteor. Soc.,* doi: 10.1175/BAMS-D-11-00180.1 (feature article).

1-M SPI (UI) versus 1-M SPI (NDMC)

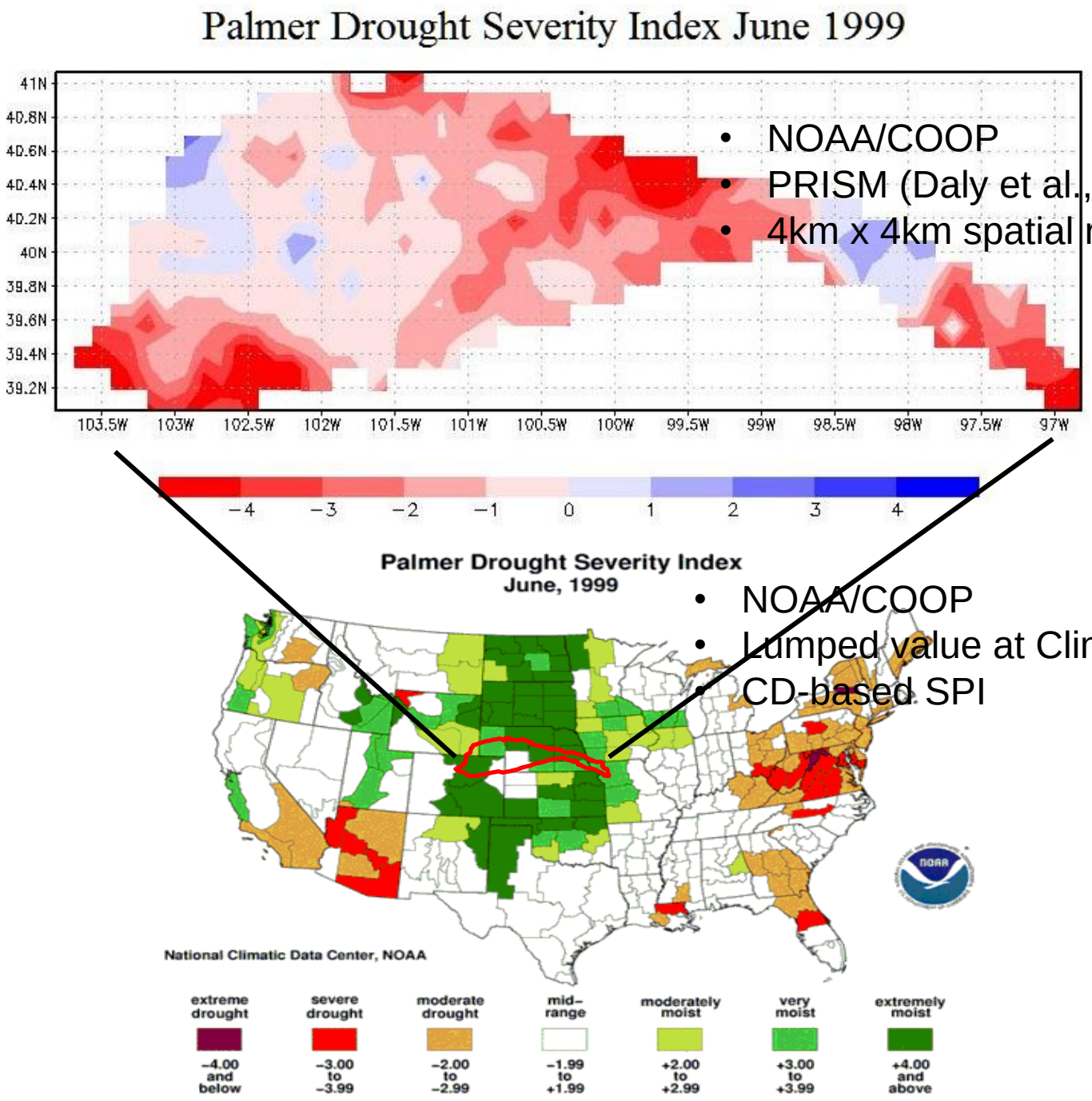


- NOAA/COOP
- PRISM (Daly et al., 1994, 1997)
- 4km x 4km spatial resolution



- NOAA/COOP
- Lumped value at Climate Division
- CD-based SPI

Self-Calibrated PDSI (UI) versus PDSI (NOAA)



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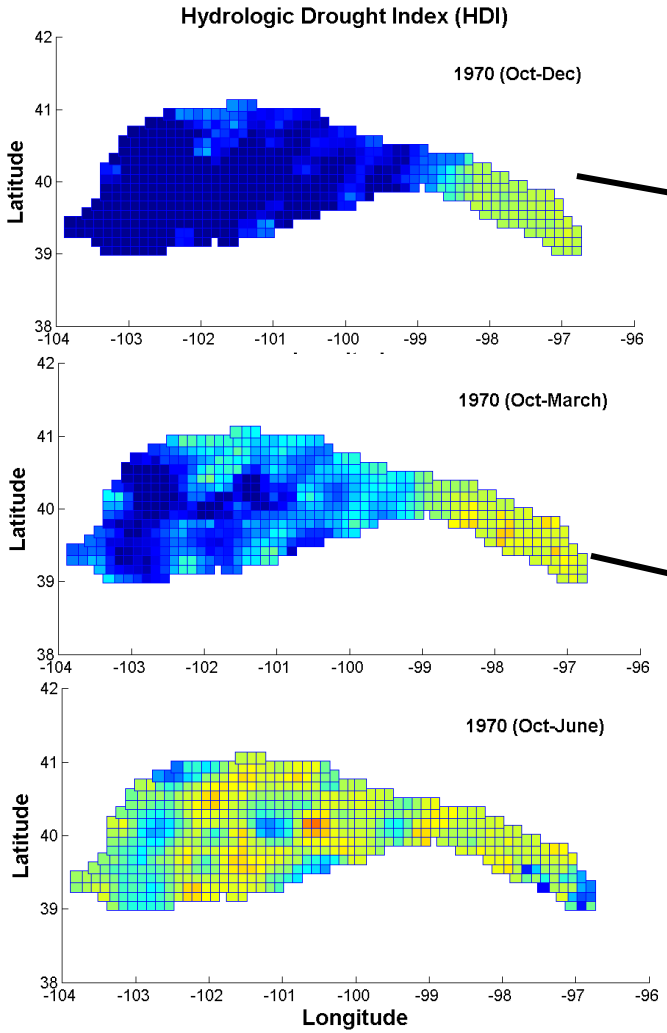
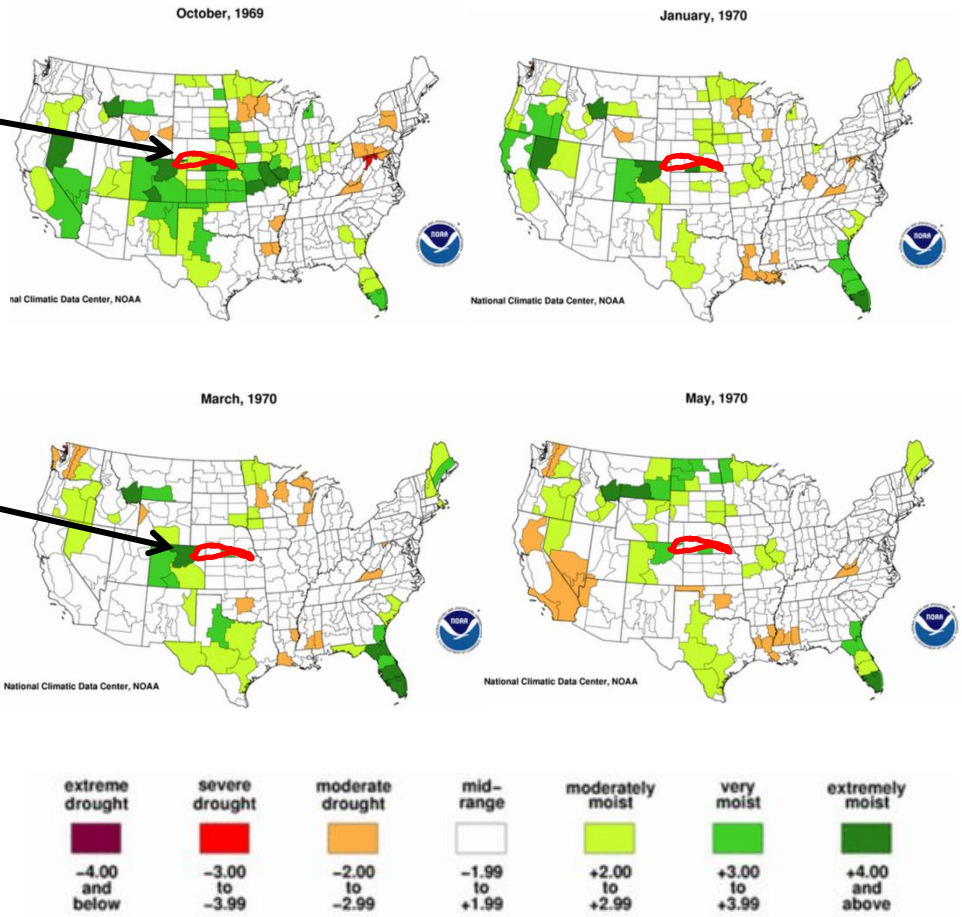
Variable Infiltration Capacity (VIC) Model

Hydrologic Drought Index (HDI)

Preliminary Results: HDI Spatial Distribution (1970)



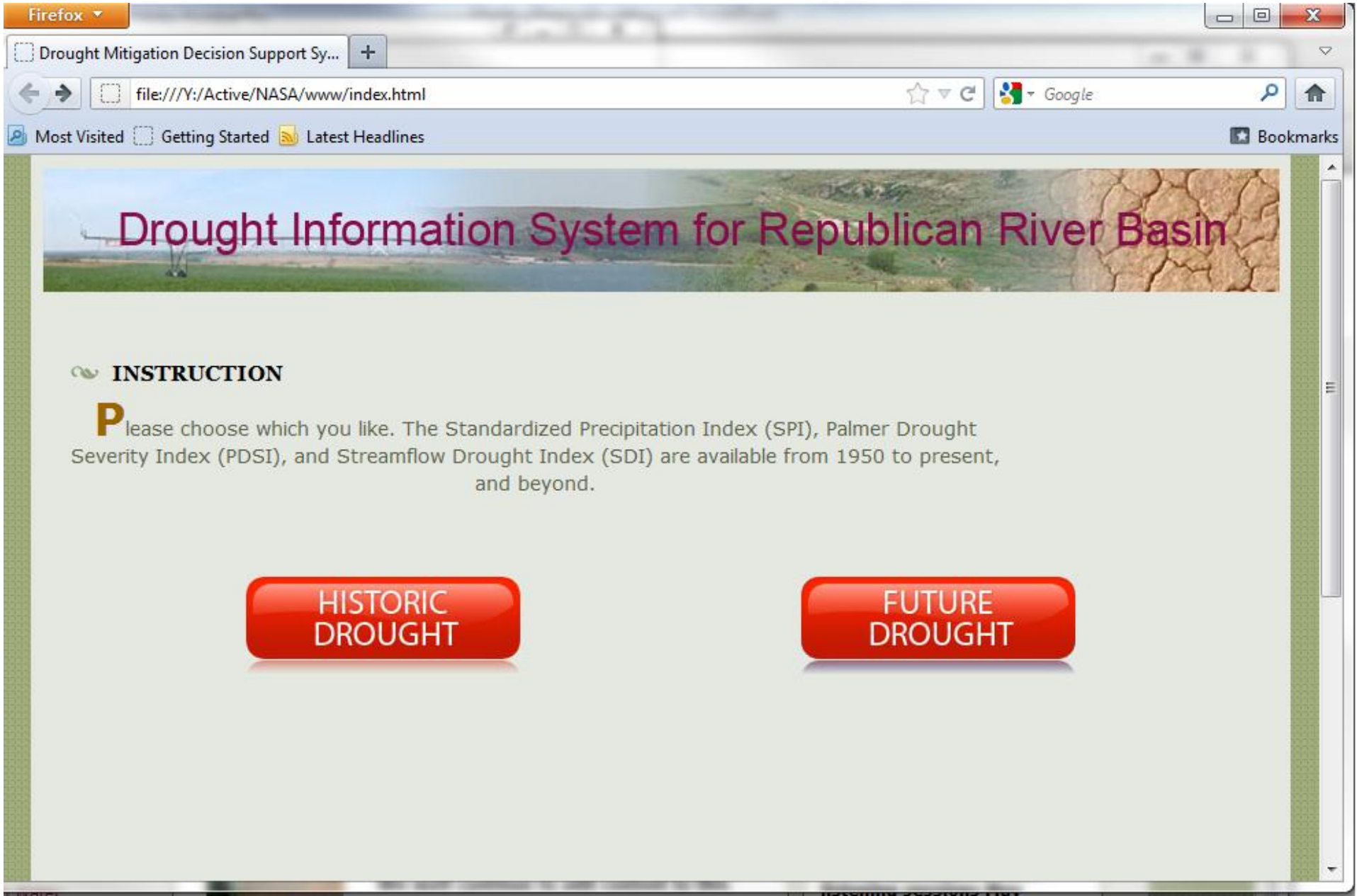
Palmer Hydrologic Drought Index (PHDI)



(http://www.ncdc.noaa.gov/oa/climate/research/prelim/drought/palmer.html)

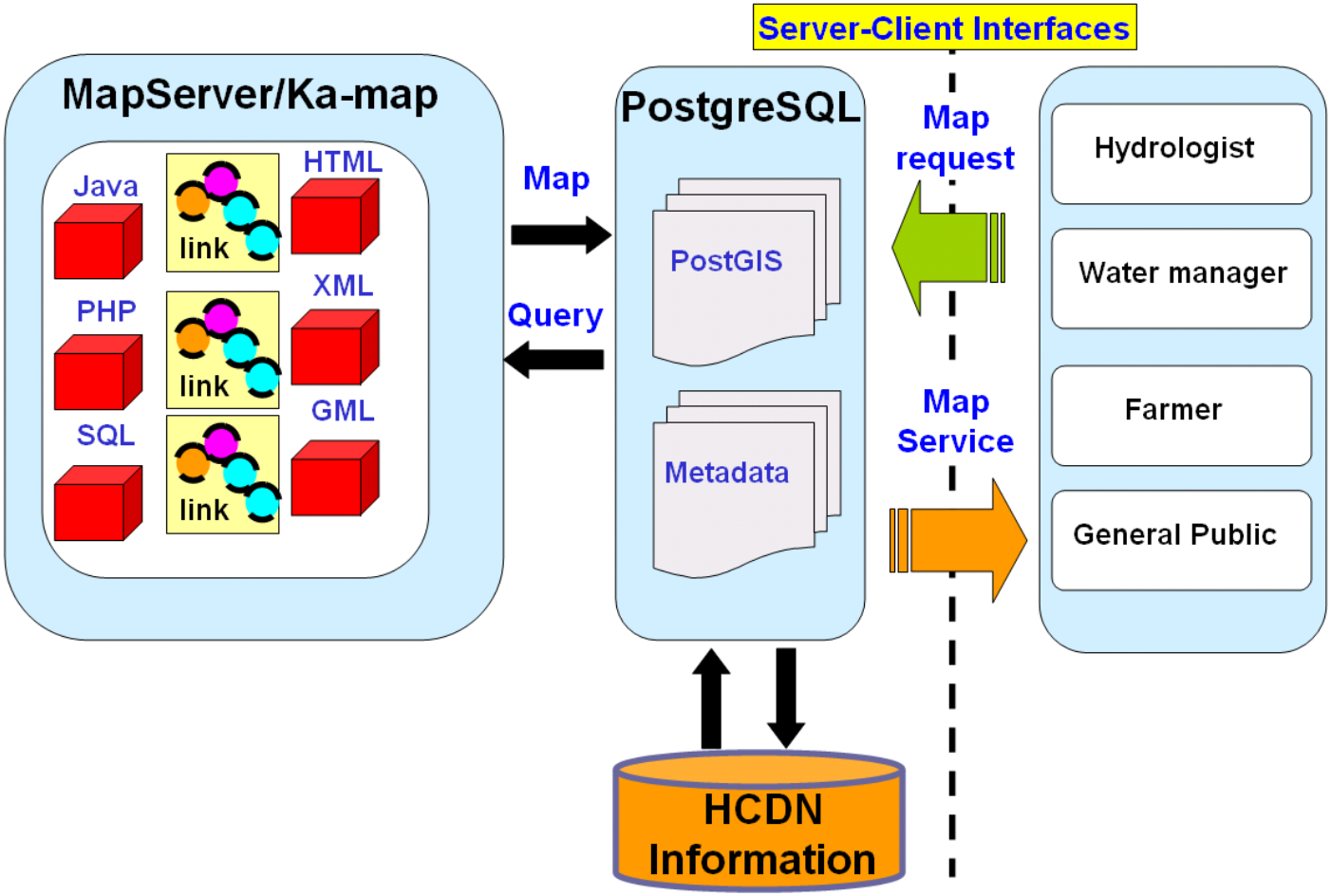
Ryu, J. H., *Sohrabi, M., Acharya, A. 2012. "Toward mapping gridded drought indices to mitigate drought impacts in a rapidly changing global environment", Bulletin of the American Meteorological Society (in review)

Users Interfaces



Users Interfaces

A Framework of Open Source Web-GIS



HCDN: Hydro-Climatic Data Network

Application of Forecast for Decision Making

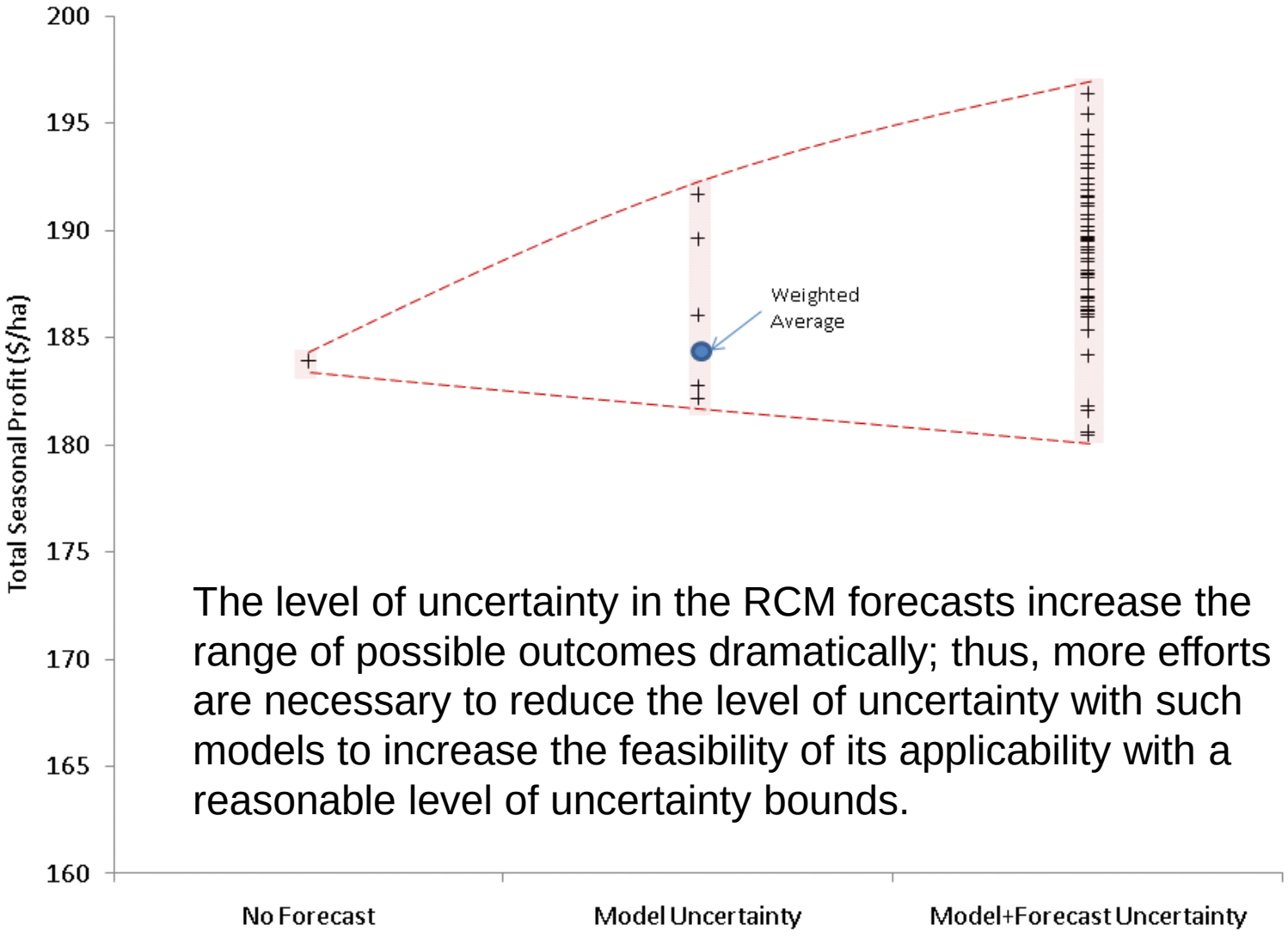
A survey with stakeholders indicates that improved forecasts will affect farmers' decision making if the statistical confidence is increased to at least 75-80%. However, currently, the forecast skills are at 67% for maximum daily temperature, 66% for minimum daily temp., and 33% for total daily precipitation.

Due to CWRF downscaling, a decision model based on a short-term forecast (up to 2 weeks) was developed to access the value of the improved forecast. This short-term forecast is needed to comply with short-term forecast requirements from NCEP and GMAO. Aptly applied for real-time irrigation scheduling, improved forecasts can increase farmers' net profit by 25-40% (Cai et al., 2011; Hejazi et al., 2012).

Cai et al. (2011), The value of probabilistic weather forecasts–An assessment by real-time optimization of irrigation scheduling, *J. of Wat. Resou Plan. and Managt.*, 137(5): 391-403.

Hejazi et al. (2012), Incorporating short-term forecasts from a regional climate model in an irrigation scheduling optimization problem, *J. of Wat. Resou Plan. and Managt.*, under review.

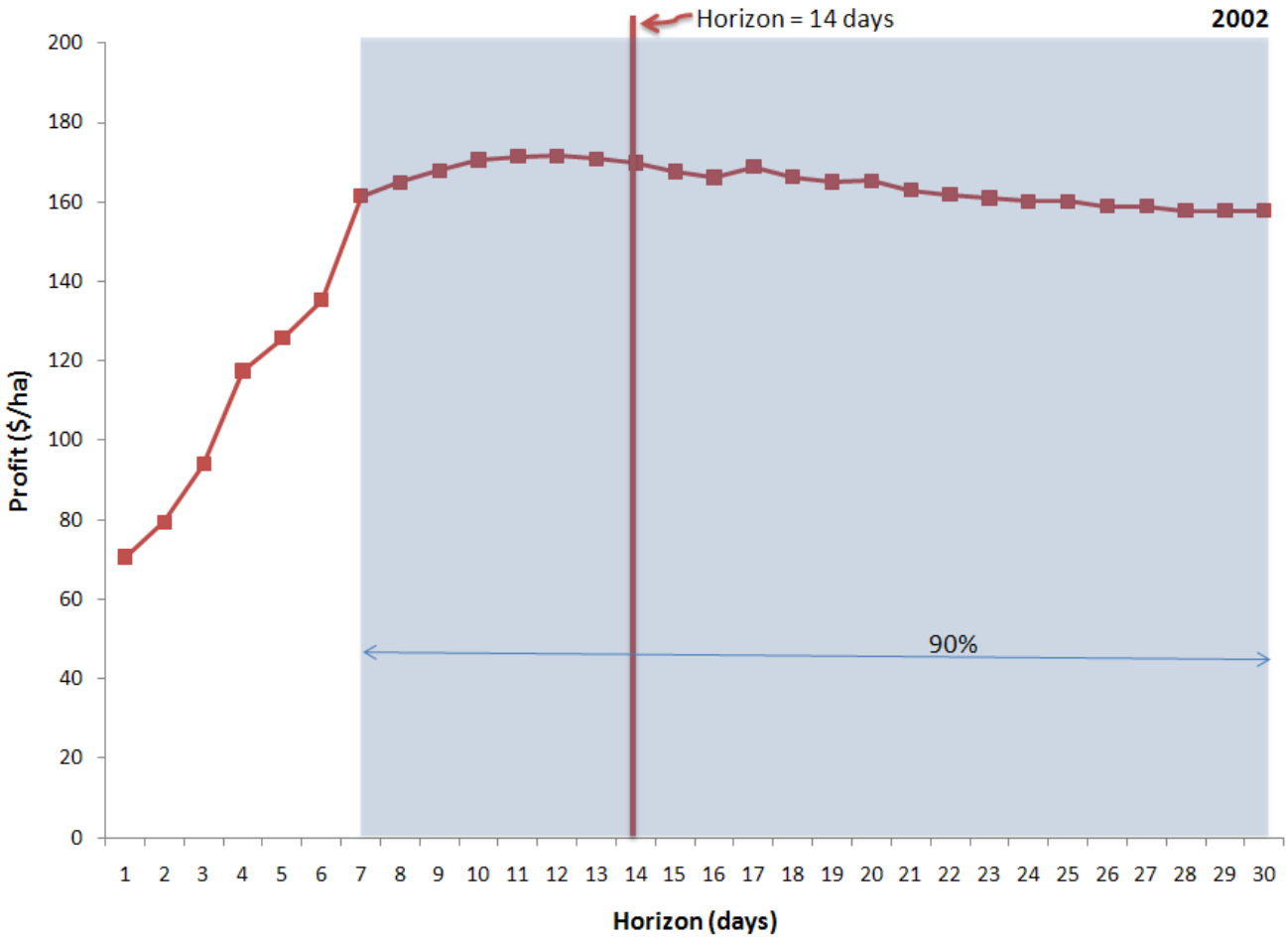
The Impact of Forecast Uncertainty



The level of uncertainty in the RCM forecasts increase the range of possible outcomes dramatically; thus, more efforts are necessary to reduce the level of uncertainty with such models to increase the feasibility of its applicability with a reasonable level of uncertainty bounds.

Propagation of uncertainty from model and forecasts on total seasonal profit in year 2004.

Forecast Horizon for Real-Time Irrigation Scheduling



Impact of forecast horizon on the overall final seasonal profit in year 2002

Ongoing Work

- **Using seasonal forecast for drought mitigation planning**
- **Assessing a historical drought**
- **Conducting a testbed study with seasonal forecast and planning for 2013 for a selected watershed in Midwest**
- **Finishing users' interfaces and incorporating products with US Drought Monitor (DM)**
- **Organizing workshops with stakeholder representatives**